

**We Claim:**

1. A photonic band-gap crystal optical waveguide comprising:  
a photonic band-gap crystal having a pitch and;  
a defect, including a core, said defect having a boundary that encloses a plane  
5 cross section and a length dimension perpendicular to the plane cross section, the defect  
boundary including a plurality of protrusions.

2. The photonic band-gap crystal optical waveguide of claim 1, wherein said  
defect has a structure such that the mode power fraction confined to said core is not less  
10 than 0.6.

3. The photonic band-gap crystal optical waveguide of claim 1, wherein said boundary  
is selected such that the mode power fraction confined to said core is not less than 0.6.

4. The photonic band-gap crystal optical waveguide of claim 1, wherein:  
said boundary is being characterized by a numerical value and the numerical  
value is selected so that the wavelength of the localized mode produced by the defect  
propagates in the wavelength range of the photonic band-gap; and  
the ratio of the numerical value of said defect to the pitch is selected to avoid the  
20 excitation of surface modes within the photonic band-gap.

5. The photonic band-gap crystal optical waveguide of claim 1, wherein:  
said boundary is being characterized by a perpendicular distance from defect  
center to the nearest point on the boundary, said distance being such that: (i) that the  
25 wavelength of the localized mode produced by the defect propagates in the wavelength  
range of the photonic band-gap; and  
the ratio of the distance to the pitch is selected to avoid the excitation of surface  
modes within the photonic band-gap.

6. The photonic band-gap crystal optical waveguide of claim 5, wherein said distance is selected so that the mode power fraction confined to the core is not less than 0.6.

5 7. The photonic band-gap crystal optical waveguide of claim 1, wherein said band-gap crystal optical waveguide is an optical fiber, said plurality of protrusions being a plurality of ribs situated along the core surface; and said boundary is being characterized a numerical value, said numerical value being the distance from core center to the nearest point on one of said ribs.

10 8. The photonic band-gap crystal optical waveguide of claim 7, wherein, said core has refractive index lower than the refractive index of material immediately surrounding said core.

15 9. The photonic band-gap crystal optical waveguide of claim 1 wherein, said defect has a circular cross section plane with said plurality of ribs protruding from the defect boundary, said boundary is being characterized a numerical value and the numerical value is the radius of the circular cross section measured to the ribs.

20 10. The photonic band-gap crystal optical waveguide according to any of the preceding claims, wherein the number of said protrusions is  $6 \times N$ , where  $N$  is a positive integer.

25 11. The photonic band-gap crystal optical waveguide of claim 1, wherein said waveguide is single mode waveguide, said defect having a circular cross section with the protruding ribs, said defect boundary is being characterized a the distance from the center of said cross-section to the nearest point on said boundary, and, for a mode power fraction confined to core of not less than 0.6, the ratio of said distance to pitch  
30 has a range from about 0.6 to 2.5.

12. The photonic band-gap crystal optical waveguide of claim 11, wherein the mode power fraction confined to said core is not less than 0.75.

5 12. The photonic band-gap crystal optical waveguide of claim 1 wherein,  
said defect is a core having a hexagonal cross section plane, the mode power  
fraction confined to said core is not less than 0.6 and the defect boundary being  
characterized by a numerical value, wherein the numerical value is the length of a line  
drawn from the center of the hexagonal cross section perpendicular to a side of the  
10 hexagon, and,

the ratio of the numerical value to pitch has a range from 0.6 to 2.5.

13. The photonic band-gap crystal optical waveguide of claim 12, wherein  
15 the mode power fraction confined to said core is not less than 0.75.

14. The photonic crystal optical band-gap waveguide comprising:  
photonic band-gap crystal having a pitch; and  
a defect, including a core, said defect having a boundary that encloses a plane cross  
20 section and a length dimension perpendicular to the plane cross section, the defect  
boundary (i) including a plurality of protrusions and (ii) being characterized by at  
least one numerical value, wherein said numerical value is measured from defect  
center to the closest point on said boundary.

25 15. The photonic band-gap crystal optical waveguide of claim 14, wherein  
the mode power fraction confined to said core is not less than 0.6.

30 16. The photonic band-gap crystal optical waveguide to claim 14, wherein  
the number of said protrusions is  $6 \times N$ , where  $N$  is a positive integer.